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Deformation of Geo Materials (Soft Ground)

state of the art at the soil mechanics laboratory at Aalborg university (AUC)

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Deformation of Geo materials (soft ground)

State of the art at the

SOIL MECHANICS LABORATORY AT AALBORG UNIVERSITY (AUC).

Consolidation- and Triaxial Apparatuses

The Consolidation- and Triaxial apparatuses in the Soil Mechanics Laboratory at AUC are developed by Prof. H. Moust Jacobsen in connection with his Ph.D. project. The apparatuses are described in the thesis *Morænelers geotekniske egenskaber* (Geotechnical properties of clay till) from 1967. The thesis, which still only exists in Danish, is reprinted in 1994.

The fundamental principles in the apparatuses are still the same, but all registration, steering gear and handling of data is fully automatic.

The registration of time and strain during the consolidation tests is thus taken automatically and continuously.

Apparatuses for measuring of cyclic and dynamic loadings.

In 1990 the Soil Mechanics Laboratory at Aalborg University was pointed out to be the Dynamic Centre in Denmark according to experiments on dynamic loaded soils.

Since then the laboratory has been under a reconstruction in order to be able to fulfil this task and it now appears with equipment for experiments with dynamic loadings.

Projects and developing works.

Deformation properties of soils. Static loading.

During the years Moust Jacobsen has carried out many tests on clay till. In 1990 he was committed to the Great Belt Investigations as a consultant in relation to investigations of the properties of slightly preconsolidated clay till.

In this connection a series of experiments were carried out partly at AUC and partly in other laboratories in Denmark. The results of the tests at AUC lead

to two papers presented at Nordisk Geoteknikermøde in Aalborg, Denmark, 1992. *Bestemmelse af forbelastningstryk i laboratoriet* (Determination of preconsolidation pressure in the laboratory) and *Karakteristiske belastningstilstande for moræneler* (Characteristic loading conditions for clay till) both of them in Danish only.

In the latter Moust Jacobsen put forward a theory for determination of creep deformations on slightly preconsolidated clay till.

As a further treatment of the results from these tests a Ph.D. project has started on the subject

Deformation of slightly preconsolidated clay till

The deformation of slightly preconsolidated Danish clay till ($OCR = 1-5$) is investigated in the laboratory by means of drained and undrained triaxial tests as well as oedometer tests.

The tests are all carried out over durations where the primary consolidation process only forms a small time part of the tests, since the primary purpose has been to study the creep deformations.

Volumetric creep behaviour has been investigated in the oedometer and in triaxial tests under isotropic stress conditions in order to obtain a detailed understanding of the influence of the stress conditions. Shear strains have been directly investigated by drained tests following the undrained stress path. Further, drained creep tests are carried out for other varieties of effective stress conditions, where combinations of volumetric strains and shear strains are measured.

The intention is to separate the creep deformations from the total deformations in order to develop a constitutive model, describing deformations of slightly preconsolidated clays.

Helle Trankjær, Ph.D. project, AUC. Will be finished May 1995.

Results from here will be presented at IS-HIROSHIMA '95, Japan, May 1995.

Preconsolidation pressure, index of consolidation, and creep settlements for clayey soils.

In connection with other projects and investigations, preconsolidation pressure, index of consolidation and creep settlements for clayey soils have been and still are investigated by means of consolidation tests.

At the very top of Denmark, "The Skaw Spit", a 220 m deep boring has shown an unusual thickness of relatively young geological deposits. 85 meters of holocene

clay and clayey silt deposits were found below 30 m sand, which has been deposited during the last 1000 years.

In order to determine the preconsolidation pressure, the index of consolidation, the size of creep deformation, and the influence of creep deformation on the apparent preconsolidation pressure, consolidation tests have been carried out with undisturbed samples extracted from the holocene layers from 30 to 115 m below the surface.

On the basis of AMS-carbon 14 datings carried out with shells and foraminifera from the holocene layers it has been possible to determine the loading history for the sediments. In so many meters of holocene clayey deposits loaded by 30 m sand within so relatively short a period, the creep deformations could possibly influence the land movements in this area. The consolidation tests have, therefore, been carried out with the purpose of studying the size of the creep deformations.

Consolidation tests have also been carried out with samples from layers of lateglacial and older deposits from other sites in Denmark.

The results of all the consolidation tests are analysed by means of different methods for determination of preconsolidation pressure and creep deformation.

These investigations form parts of projects carried out in co-operation with geologists, land surveyors, archaeologists etc. Project manager for the soil mechanics parts of the projects is Grete Thorsen.

Results from the consolidation tests will be presented at IS-HIROSHIMA '95, Japan, May 1995 and at the XI ECSMFE Copenhagen '95, May 1995.

Deformation properties of organic soils.

Consolidation tests are carried out with samples from organic layers in order to determine the deformation properties. Samples from different sites form parts of the investigation, whenever the opportunity offers, i.e. samples from borings carried out in connection with the motorway projects in Vendsyssel.

Project at AUC: Grete Thorsen.

In the northern part of Jutland some road embankments have been constructed on soft organic soils. The size of the settlements are reduced by preloading, and the deformations have been observed for a number of years.

Some of the results are published in a paper *Secondary settlements of 4 Danish road embankments on soft soils* by Mogens B. Jørgensen and presented at IXth ECSMFE, Dublin 1987.

Deformations in a soft-bed area below a motorway embankment near Bjergby, Vendsyssel.

For the first time ever in Denmark it has been decided to reduce the settlements for a motorway embankment over a soft-bed area by means of preloading.

The project is carried out in collaboration with Kampsax-Geodan.

Project start: June 1994.

Project manager at AUC: Mogens B. Jørgensen.

Soil properties due to cyclic and dynamic loading.

Determination of soil properties due to cyclic and dynamic loading has been carried out during a number of years in the Soil Mechanics Laboratory at AUC. The first Ph.D.-study within this field was finished in March 1993.

Poretryksoptygning i sand. (Fatigue in sand.) Ph.D.-thesis (in Danish)
by Lars Bo Ibsen, AUC, 1993.

A Ph.D.-study concerning

The behaviour of footings during dynamic loading

is in progress by Morten Schousboe Rasmussen.

The objective of this project is to determine the movements of and the drainage below a footing. Movement and drainage are investigated by a series of dynamic loads. The influence of the frequency together with the influence of the amplitude and the elaboration of the forces are some of the parameters to investigate.

The project will be finished in August 1995.

Results from the project will be presented at the First International Conference on Earthquake, Geotechnical Engineering, IS Tokyo, Japan, November 1995.

A number of projects concerning soil testing during cyclic and dynamic loadings are in progress at the Soil Mechanics Laboratory.

Litaseis. Nørre Lyngby.

An EU-project in collaboration with geologists from Århus University and some German universities. In the laboratory at AUC the static and dynamic properties of clay soils from Nørre Lyngby are investigated by consolidation tests and resonant column tests. The purpose of these tests is to form a basis for an evaluation of the influence of soil properties on the quality of the seismic signals from the area.

The project will be finished in 1995.

Project manager at AUC: Grete Thorsen.

The following projects are made in co-operation with Delft Geotechnics and the Norwegian Geotechnical Institute.

Project manager at AUC: Lars Bo Ibsen.

Dynamic Soil Characteristics.

An EEC - MAST II project: Monolithic Coastal Structures.

Evaluation of the dynamic properties of the rubble mound foundation and the soil beneath the structure which are required for the prediction of the dynamic response of the monolithic structure and its foundation due to impact load.

Start: February 1993.

End: July 1995.

Numerical Modelling of Structure – Foundation Interaction.

An EEC - MAST II project: Monolithic Coastal Structures.

Development of numerical models for the simulation of structure-foundation interaction.

Start: February 1993.

End: July 1995.

Dynamic Response of Coarse Granular Materials to Wave Load.

A Danish Research Councils project.

Development of a rational method for the design of concrete superstructures on rubble mound breakwaters and the design of monolithic caisson structures and rubble mound foundation. The special contribution from the present project is mainly to provide the soil mechanics part of the design tools.

Start: August 1993.

End: August 1996.

Behaviour of structures subjected to dynamic loadings.

A Danish Research Councils project.

The purpose is to study the interaction between vibrating structure and soil. The project consists of theoretical surveys and considerations, in situ measurements which includes a comprehensive pilot project by measuring projects and advanced numerical calculations.

Start: August 1994.

End: August 1997.